Rec'd PCT/PTO 18 JUL 2001

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/806,974	PCT/DE99/00037 09/806974	112740-203

21. The following fees are submitted:.

	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO $1,000.00		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO $860.00		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $710.00		
☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) $690.00		
☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$0.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☒ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	$130.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	- 20 =	0	x $18.00	$0.00	
Independent claims	- 3 =	0	x $80.00	$0.00	
Multiple Dependent Claims **(check if applicable)**.			☐	$0.00	
TOTAL OF ABOVE CALCULATIONS =				$130.00	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable)**. ☐				$0.00	
SUBTOTAL =				$130.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				$0.00	
TOTAL NATIONAL FEE =				$130.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐				$0.00	
TOTAL FEES ENCLOSED =				$130.00	
07/20/2001 HNGUYEN 00000070 09806974				Amount to be: refunded	$
01 FC:154 130.00 OP				charged	$

☒ A check in the amount of **$130.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **02-1818** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

William E. Vaughan (Reg. No. 39,056)
Bell, Boyd & Lloyd LLC
P.O. Box 1135
Chicago, Illinois 60690

SIGNATURE

William E. Vaughan
NAME

39,056
REGISTRATION NUMBER

July 18, 2001
DATE

FORM PTO-1390 (Modified) (REV 11-98) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: **112740-203**

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR): **09/806974**

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE99/00037	**12 January 1999**	**06 October 1998**

TITLE OF INVENTION

TRANSMISSION OUTPUT STAGE FOR A MOBILE TELEPHONE

APPLICANT(S) FOR DO/EO/US

Thomas Moliere

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☒ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Submission of Drawings Figures 1-2 on two sheets

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/806974	PCT/DE99/00037	112740-203

21. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS	PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO $1,000.00		
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO $860.00		
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☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00		
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	Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	$0.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	13 - 20 =	0	x $18.00	$0.00	
Independent claims	1 - 3 =	0	x $80.00	$0.00	
Multiple Dependent Claims **(check if applicable)** .			☐	$0.00	
	TOTAL OF ABOVE CALCULATIONS =			$860.00	
	Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable)** . ☐			$0.00	
	SUBTOTAL =			$860.00	
	Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +			$0.00	
	TOTAL NATIONAL FEE =			$860.00	
	Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐			$0.00	
	TOTAL FEES ENCLOSED =			$860.00	
				Amount to be: refunded	$
				charged	$

☒ A check in the amount of **$860.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees.
A duplicate copy of this sheet is enclosed.

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NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

William E. Vaughan
Bell, Boyd & Lloyd LLC
P.O. Box 1135
Chicago, IL 60690-1135

SIGNATURE

William E. Vaughan
NAME

39,056
REGISTRATION NUMBER

April 6, 2001
DATE

BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANT:	Thomas Moliere	DOCKET NO: 112740-203
SERIAL NO:		GROUP ART UNIT:
		EXAMINER:
INTERNATIONAL APPLICATION NO:		PCT/DE99/00037
INTERNATIONAL FILING DATE:		12 January 1999
INVENTION:	TRANSMISSION OUTPUT STAGE FOR A MOBILE TELEPHONE	

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

Please amend the above-identified International Application before entry into the National stage before the U.S. Patent and Trademark Office under 35 U.S.C. §371 as follows:

In the Specification:

Please replace the Specification of the present application, including the Abstract, with the following Substitute Specification:

SPECIFICATION

TITLE

TRANSMISSION OUTPUT STAGE FOR A MOBILE TELEPHONE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a transmission output stage for a mobile telephone and, in particular, to a transmission stage for such a mobile telephone which is designed for two frequency bands.

Description of the Prior Art

At present, multiband mobile telephones are being developed and the first types are on the market which can operate at two operating frequencies, that is to say at 900 MHz and 1800 MHz in Europe in accordance with the relevant system definitions, and at 900 MHz and 1900 MHz frequencies in the USA.

First developments operate with narrow-band parallel amplifier chains in the transmit and receive section. Such dual-band output stages thus have, for each frequency band, an amplifier optimized for this band which is associated with a considerable expenditure on components and, therefore, with costs and space requirements. A dual-band output stage of this type having separate amplifier branches for each band is, for example, the TST0911 chip by the manufacturer TEMIC. When the chip is used in a mobile telephone, the two outputs of the chip are conducted to an antenna via a diplexer. Here, too, the disadvantages are the costs and the circuit board area needed and the necessary expenditure for filtering the harmonics.

To lower costs, the aim is to be able to process the two frequency bands with one amplifier chain. Thus, in the article by V. Güngerich, M. Pöbl: "Bessere Handys durch Gallium-Arsenid MMICs" [Better mobile telephones by using Gallium-Arsenid MMICs], Elektronik 8/1998, p. 90-96, the structure of a CGY0819 amplifier chip by Siemens for multifrequency mobile telephones is described which exhibits separate RF inputs, the signals being conducted via a narrow-band amplifier in the respective band and the necessary output power being generated in a common output stage. In this arrangement, the preliminary stages can be switched on and off separately from one another depending on the operating state.

Since, therefore, the common output amplifier operates both for 900 MHz and for 1800 MHz, it is mandatorily of wide-band design. In 900 MHz operation, a strong first harmonic is, therefore, mandatorily produced at 1800 MHz. This harmonic can only be suppressed with additional filters which result in considerable insertion loss of the useful signal at the fundamental frequency and need which additional components. Furthermore, the matching elements must be elaborately switched with the aid of switches; for example, PIN diode switches or diplex filters at the output of the transmit transistor.

The present invention is, therefore, directed to a transmission output stage for a multifrequency mobile radio device which simplifies the critical switching of the output match of a dual-band transmission output stage for both frequency bands with simultaneous good suppression of the first harmonic of the lower-frequency signal.

SUMMARY OF THE INVENTION

Accordingly, in a transmission output stage according to the present invention for a multifrequency mobile telephone, the transmit signal is generated by a push-pull output stage during operation at the low frequency whereas the transmit signal is generated in single-ended operation of the push-pull output stage during operation at the higher frequency.

The single-ended operation can be generated by coupling the signal out of only one output transistor whereas the other output transistor is cut off. Furthermore, the single-ended operation can be achieved by switching off the supply voltage or cutting off the transistors for one branch of the push-pull output stage. It is also possible to arrange in one branch of the push-pull amplifier a switch which causes this branch to be short-circuited when the transmission output stage is operated in single-ended mode. For this purpose, a PIN diode switch or an FET switch is preferably used.

The transmission output stage preferably exhibits an output matching circuit. The transmission output stage can also exhibit a harmonic filter

for the low frequency and a harmonic filter for the high frequency, the transmission output stage also exhibiting a switch which conducts the signal to the appropriate harmonic filter in accordance with the frequency band currently used.

Furthermore, an LC transformer which is used for matching the load impedance of the high-frequency branch to the antenna impedance is arranged in the output branch of the high frequency.

The output to the antenna or to the antenna combiner for the high-frequency band is preferably blocked during operation in the low-frequency band in the transmission output stage. A switch which is implemented by a PIN diode switch or an FET switch can be used for blocking the output to the antenna or to the antenna combiner.

Either 900 MHz and 1800 MHz or 900 MHz and 1900 MHz are preferably used as frequencies. In this case, the first set of frequencies, namely 900 MHz and 1800 MHz, is used in Europe whereas a device is ready to operate in Europe and the USA with the second set of frequencies; i.e., 900 MHz and 1900 MHz.

The present invention has the following advantages. Due to the push-pull operation for generating the output power at the lower frequency via a push-pull output stage, the first harmonic is already additionally suppressed by 20...30 dB which considerably lowers the expenditure for suppressing harmonics. Since the power is distributed to two transistors or branches of the push-pull output stage, the same amount of semiconductor material is required as in the single-ended operation with one transistor previously used. During operation at the higher frequency, single-ended operation is carried out as explained above. Since, in the case of GSM, the doubled frequency (1800 MHz) requires only half the power as the low frequency (900 MHz), the transistor (the transistors) is optimally driven in both bands. Furthermore, with the design of the matching circuit according to the present invention, the matching elements of the push-pull

circuit can also be used for the single-ended coupling-out at the doubled frequency which further reduces the circuit expenditure.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Preferred Embodiments and the Drawings.

DESCRIPTION OF THE DRAWINGS

Figure 1 shows a circuit diagram of a first embodiment of the present invention, and

Figure 2 shows a circuit diagram of a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiment of Figure 1 diagrammatically shows a push-pull amplifier GTV which exhibits an upper branch consisting of transistors T_1 and T_2 and a lower branch consisting of transistors T_3 and T_4 to which the input signal is applied via a transformer TF. For each transistor T_1, T_2, T_3 and T_4, a radio-frequency choke D is diagrammatically drawn in each case. The actual internal wiring or implementation of the push-pull amplifier is of no significance here and is not, therefore, shown. The only significant factor is that the push-pull amplifier GTV outputs two output voltages which are phase-shifted by 180°. These output signals are conducted, via an output matching circuit consisting of the capacitances C_1 and C_2 and an inductance L_1 in the upper branch and the capacitances C_3 and C_4 and the inductance L_2 in the lower branch, to a switch S for the case of operation at 900 MHz. The output matching circuit provides an impedance match and a resultant phase difference of 0^0 of the two signals due to the LC section L_1, C_2 of the upper branch and the LC section C_4 ,L_2 of the lower branch. The first harmonic which is at 1800 MHz with an operation at 900 MHz is already suppressed by 20 to 30 dB by using the push-pull amplifier. To completely meet the requirements of the GSM standard at 900 MHz operation, the signal is conducted via the switch S to a harmonic filter OWF_n which performs the

appropriate filtering. The transmit signal passes to an antenna A via a combiner CB.

When the transmission output switch is operated at 1800 MHz, the push-pull amplifier GTV is operated in single-ended mode by deactivating, for example, the lower branch. This can be done by cutting off the lower branch T_3 and T_4, for example by switching off the direct-voltage supply of the lower branch, or connecting (short-circuiting) the base, for example of the transistor T_4 (or T_3), to ground via a PIN diode switch. The signal of the push-pull amplifier GTV in single-ended mode is passed via the high-pass filter formed by the elements C_1, C_2 and L_1 through to the switch S which, in the 1800 MHz position, applies the signal to an LC transformer which produces the necessary impedance match to the antenna A. The signal is then filtered in a harmonic filter OWF_n for the high frequency in order to filter the harmonics out of the signal in accordance with the GSM standard. The transmit signal passes through the antenna A via the combiner CB.

Figure 2 shows a second embodiment of the transmit stage which differs from the embodiment of Figure 1 in the output matching circuit. The output signals of the push-pull amplifier GTV here pass to an LC transformer consisting of the inductances L_3 and L_4 and the capacitance C_5, which is followed by a push-pull transformer TF_2, in the case of operation at the lower frequency, the switch S being set to the lower position for the 900 MHz operation. This output matching circuit provides for the necessary impedance match to the antenna and for a phase difference of 0° of the signals so that these are combined in the correct phase before the harmonic filter OWF_n for the low frequency.

In the case where the transmission output stage is operated at the high frequency, 1800 MHz in this case, the push-pull amplifier is operated in single-ended mode as in the first embodiment of Figure 1 and the output signal passes via the switch, which is in the 1800 MHz position, directly to the upper

branch consisting of an LC transformer LCT and the harmonic filter OWF_h for the high frequency.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

ABSTRACT OF THE DISCLOSURE

In a transmission output stage for a multifrequency mobile telephone, the transmit signal of operation at the low frequency is generated by a push-pull output stage which is operated in single-ended mode for generating the transmit signal at the higher frequency.

In the claims:

On page 7, cancel line 1, and substitute the following left-hand justified heading therefor:

I Claim as My Invention:

Please cancel claims 1-12, without prejudice, and substitute the following claims therefor:

13. A transmission output stage for a multifrequency mobile telephone, comprising a push-pull amplifier having first and second outputs, wherein a transmit signal is generated by the push-pull amplifier via both the first and second outputs during operation at a lower frequency, and the transmit signal is generated in single-ended operation of the push-pull amplifier via only the first output during operation at a higher frequency.

14. A transmission output stage for a multifrequency mobile telephone as claimed in claim 13, wherein the push-pull amplifier further includes a first output transistor associated with the first output and a second output transistor associated with the second output, such that the single-ended operation is generated by coupling the signal out of only the first output transistor while the second output transistor is cut off.

15. A transmission output stage of a multifrequency mobile telephone as claimed in claim 14, wherein the push-pull amplifier further includes a first branch associated with both the first output transistor and the first output, and a second branch associated with both the second output transistor and the second output, such that the single-ended operation is achieved by switching off one of a supply voltage to the second branch and the second transistor.

16. A transmission output stage for a multifrequency mobile telephone as claimed in claim 14, wherein the push-pull amplifier further includes a first branch associated with both the first output transistor and the first output, a second branch associated with both the second output transistor and the second output, and a switch arranged in the second branch which causes the second branch to be short-circuited during single-ended operation.

17. A transmission output stage for a multifrequency mobile telephone as claimed in claim 16, wherein the switch is one of a PIN diode switch and an FET switch.

18. A transmission output stage for a multifrequency mobile telephone as claimed in claim 13, further comprising an output matching circuit connected to the first and second outputs of the push-pull amplifier.

19. A transmission output stage for a multifrequency mobile telephone as claimed in claim 18, further comprising a first harmonic filter for the lower frequency, a second harmonic filter for the higher frequency, and a further switch which conducts the transmit signal to the respective first and second harmonic filters depending upon the frequency used.

20. A transmission output stage for a multifrequency mobile telephone as claimed in claim 19, further comprising an LC transformer arranged in a branch of the first harmonic filter.

21. A transmission output stage for a multifrequency mobile telephone as claimed in claim 19, further comprising an LC transformer arranged in a branch of the second harmonic filter.

22. A transmission output stage for a multifrequency mobile telephone as claimed in claim 13, further comprising at least one of an antenna and an antenna combiner, wherein an output to the at least one of the antenna and the antenna combiner for the higher frequency is blocked during operation in the lower frequency.

23. A transmission output stage of a multifrequency mobile telephone as claimed in claim 21, wherein at least one of a PIN diode switch and an FET switch is used to block the output to the at least one of the antenna and the antenna combiner for the higher frequency.

24. A transmission output stage for a multifrequency mobile telephone as claimed in claim 13, wherein the lower frequency is approximately 900 MHz and the higher frequency is approximately 1800 MHz.

25. A transmission output stage for a multifrequency mobile telephone as claimed in claim 13, wherein the lower frequency is approximately 900 MHz and the higher frequency is approximately 1900 MHz.

REMARKS

The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the specification to the requirements of United States Patent Practice. No new matter is added thereby. Attached hereto is a marked-up version of the changes made to the specification by the present amendment. The attached page is captioned "**Version With Markings To Show Changes Made**".

In addition, the present amendment cancels original claims 1-12 in favor of new claims 13-24. Claims 13-24 have been presented solely because the revisions by red-lining and underlining which would have been necessary in claims 1-12 in order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 USC

§§103, 102, 103 or 112. Indeed, the cancellation of claims 1-12 does not constitute an intent on the part of the Applicant to surrender any of the subject matter of claims 1-12.

Early consideration on the merits is respectfully requested.

Respectfully submitted,

(Reg. No. 39,056)

William E. Vaughan
Bell, Boyd & Lloyd LLC
P.O. Box 1135
Chicago, Illinois 60690-1135
(312) 807-4292
Attorneys for Applicants

VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

In The Specification:

The Specification of the present application, including the Abstract, has been amended as follows:

SPECIFICATION

TITLE

TRANSMISSION OUTPUT STAGE FOR A MOBILE TELEPHONE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a transmission output stage for a mobile telephone and, in particular, ~~relates~~ to a transmission stage for such a mobile telephone which is designed for two frequency bands.

Description of the Prior Art

At present, multiband mobile telephones are being developed and the first types are on the market which can operate at two operating frequencies, that is to say at 900 MHz and 1800 MHz in Europe in accordance with the relevant system definitions, and at ~~whereas the~~ 900 MHz and 1900 MHz frequencies ~~are being used~~ in the USA.

First developments operate with narrow-band parallel amplifier chains in the transmit and receive section. Such dual-band output stages thus have, for each frequency band, an amplifier optimized for this band which is associated with a considerable expenditure on components and, therefore, with costs and space requirements. A dual-band output stage of this type having separate amplifier branches for each band is, for example, the TST0911 chip by the manufacturer TEMIC. When the chip is used in a mobile telephone, the two outputs of the chip are conducted to an antenna via a diplexer. Here, too, the disadvantages are the costs and the circuit board area needed and the necessary expenditure for filtering the harmonics.

To lower costs, the aim is to be able to process the two frequency bands with one amplifier chain. Thus, in the article by V. Güngerich, M. Pöbl: "Bessere Handys durch Gallium-Arsenid MMICs" [Better mobile telephones by using Gallium-Arsenid MMICs], Elektronik 8/1998, p. 90-96, the structure of a CGY0819 amplifier chip by Siemens for multifrequency mobile telephones is described which exhibits separate RF inputs, the signals being conducted via a narrow-band amplifier in the respective band and the necessary output power being generated in a common output stage. In this arrangement, the preliminary stages can be switched on and off separately from one another depending on the operating state.

Since, therefore, the common output amplifier operates both for 900 MHz and for 1800 MHz, it is mandatorily of wide-band design. In 900 MHz operation, a strong first harmonic is, therefore, mandatorily produced at 1800 MHz. This harmonic can only be suppressed with additional filters which result in considerable insertion loss of the useful signal at the fundamental frequency and need which additional components. Furthermore, the matching elements must be elaborately switched with the aid of switches; for example, PIN diode switches or diplex filters at the output of the transmit transistor.

The present invention is, therefore, directed to ~~based on the object of creating~~ a transmission output stage for a multifrequency mobile radio device which simplifies the critical switching of the output match of a dual-band transmission output stage for both frequency bands with simultaneous good suppression of the first harmonic of the lower-frequency signal.

~~The object is achieved by the features of claim 1. Preferred embodiments of the invention are the subject matter of the subclaims.~~

SUMMARY OF THE INVENTION

Accordingly, in ~~In~~ a transmission output stage according to the present invention for a multifrequency mobile telephone, the transmit signal is generated by a push-pull output stage during operation at the low frequency

whereas the transmit signal is generated in single-ended operation of the push-pull output stage during operation at the higher frequency.

The single-ended operation can be generated by coupling the signal out of only one output transistor whereas the other output transistor is cut off. Furthermore, the single-ended operation can be achieved by switching off the supply voltage or cutting off the transistors for one branch of the push-pull output stage. It is also possible to arrange in one branch of the push-pull amplifier a switch which causes this branch to be short-circuited when the transmission output stage is operated in single-ended mode. For this purpose, a PIN diode switch or an FET switch is preferably used.

The transmission output stage preferably exhibits an output matching circuit. The transmission output stage can also exhibit a harmonic filter for the low frequency and a harmonic filter for the high frequency, the transmission output stage also exhibiting a switch which conducts the signal to the appropriate harmonic filter in accordance with the frequency band currently used.

Furthermore, an LC transformer which is used for matching the load impedance of the high-frequency branch to the antenna impedance is arranged in the output branch of the high frequency.

The output to the antenna or to the antenna combiner for the high-frequency band is preferably blocked during operation in the low-frequency band in the transmission output stage. A switch which is implemented by a PIN diode switch or an FET switch can be used for blocking the output to the antenna or to the antenna combiner.

Either 900 MHz and 1800 MHz or 900 MHz and 1900 MHz are preferably used as frequencies. In this case, the first set of frequencies, namely 900 MHz and 1800 MHz, is used in Europe whereas a device is ready to operate in Europe and the USA with the second set of frequencies; i.e., 900 MHz and 1900 MHz.

The present invention has the following advantages.~~:~~ Due ~~due~~ to the push-pull operation for generating the output power at the lower frequency via ~~by means of~~ a push-pull output stage, the first harmonic is already additionally suppressed by 20...30 dB which considerably lowers the expenditure for suppressing harmonics. Since the power is distributed to two transistors or branches of the push-pull output stage, the same amount of semiconductor material is required as in the single-ended operation with one transistor previously used. During operation at the higher frequency, single-ended operation is carried out as explained above. Since, in the case of GSM, the doubled frequency (1800 MHz) requires only half the power as the low frequency (900 MHz), the transistor (the transistors) is optimally driven in both bands. Furthermore, with the design of the matching circuit according to the present invention, the matching elements of the push-pull circuit can also be used for the single-ended coupling-out at the doubled frequency which further reduces the circuit expenditure.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Preferred Embodiments and the Drawings.

~~In the text which follows, preferred embodiments of the invention will be explained with reference to the drawings, in which:~~

DESCRIPTION OF THE DRAWINGS

Figure 1 shows a circuit diagram of a first embodiment of the present invention, and

Figure 2 shows a circuit diagram of a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiment of Figure ~~figure~~ 1 diagrammatically shows a push-pull amplifier GTV which exhibits an upper branch consisting of transistors T_1 and T_2 and a lower branch consisting of transistors T_3 and T_4 to which the input signal is applied via a transformer TF. For each transistor T_1, T_2,

T_3 and T_4, a radio-frequency choke D is diagrammatically drawn in each case. The actual internal wiring or implementation of the push-pull amplifier is of no significance here and is not, therefore, shown. The only significant factor is that the push-pull amplifier GTV outputs two output voltages which are phase-shifted by 180°. These output signals are conducted, via an output matching circuit consisting of the capacitances C_1 and C_2 and an inductance L_1 in the upper branch and the capacitances C_3 and C_4 and the inductance L_2 in the lower branch, to a switch S for the case of operation at 900 MHz. The output matching circuit provides an impedance match and a resultant phase difference of 0^0 of the two signals due to the LC section L_1, C_2 of the upper branch and the LC section C_4~~L_4~~, L_2 of the lower branch. The first harmonic which is at 1800 MHz with an operation at 900 MHz is already suppressed by 20 to 30 dB by using the push-pull amplifier. To completely meet the requirements of the GSM standard at 900 MHz operation, the signal is conducted via the switch S to a harmonic filter OWF_n which performs the appropriate filtering. The transmit signal passes to an antenna A via a combiner CB.

When the transmission output switch is operated at 1800 MHz, the push-pull amplifier GTV is operated in single-ended mode by deactivating, for example, the lower branch. This can be done by cutting off the lower branch T_3 and T_4, for example by switching off the direct-voltage supply of the lower branch, or connecting (short-circuiting) the base, for example of the transistor T_4 (or T_3), to ground via ~~by means of~~ a PIN diode~~s~~ switch. The signal of the push-pull amplifier GTV in single-ended mode is passed via the high-pass filter formed by the elements C_1, C_2 and L_1 through to the switch S which, in the 1800 MHz position, applies the signal to an LC transformer which produces the necessary impedance match to the antenna A. The signal is then filtered in a harmonic filter OWF_n for the high frequency in order to filter the harmonics out of the signal in accordance with the GSM standard. The transmit signal passes through the antenna A via the combiner CB.

Figure 2 shows a second embodiment of the transmit stage which differs from the embodiment of Figure ~~figure~~ 1 in the output matching circuit. The output signals of the push-pull amplifier GTV here pass to an LC transformer consisting of the inductances L_3 and L_4 and the capacitance C_5, which is followed by a push-pull transformer TF_2, in the case of operation at the lower frequency, the switch S being set to the lower position for the 900 MHz operation. This output matching circuit provides for the necessary impedance match to the antenna and for a phase difference of 0° of the signals so that these are combined in the correct phase before the harmonic filter OWF_n for the low frequency.

In the case where the transmission output stage is operated at the high frequency, 1800 MHz in this case, the push-pull amplifier is operated in single-ended mode as in the first embodiment of Figure ~~figure~~ 1 and the output signal passes via the switch, which is in the 1800 MHz position, directly to the upper branch consisting of an LC transformer LCT and the harmonic filter OWF_h for the high frequency.

In sum, although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

~~Abstract~~

ABSTRACT OF THE DISCLOSURE

~~Transmission output stage for a mobile telephone~~

In a transmission output stage for a multifrequency mobile telephone, the transmit signal of operation at the low frequency is generated by a push-pull output stage which is operated in single-ended mode for generating the transmit signal at the higher frequency.

~~Fig. 1~~

BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

APPLICANT:	Thomas Moliere	DOCKET NO: 112740-203
SERIAL NO:		GROUP ART UNIT:
		EXAMINER:

INTERNATIONAL APPLICATION NO: PCT/DE99/00037

INTERNATIONAL FILING DATE: 12 January 1999

INVENTION: TRANSMISSION OUTPUT STAGE FOR A MOBILE TELEPHONE

Assistant Commissioner for Patents,
Washington, D.C. 20231

SUBMISSION OF DRAWINGS

Applicant herewith submits two sheets (Figs. 1-2) of drawings for the above-referenced PCT application.

Respectfully submitted,

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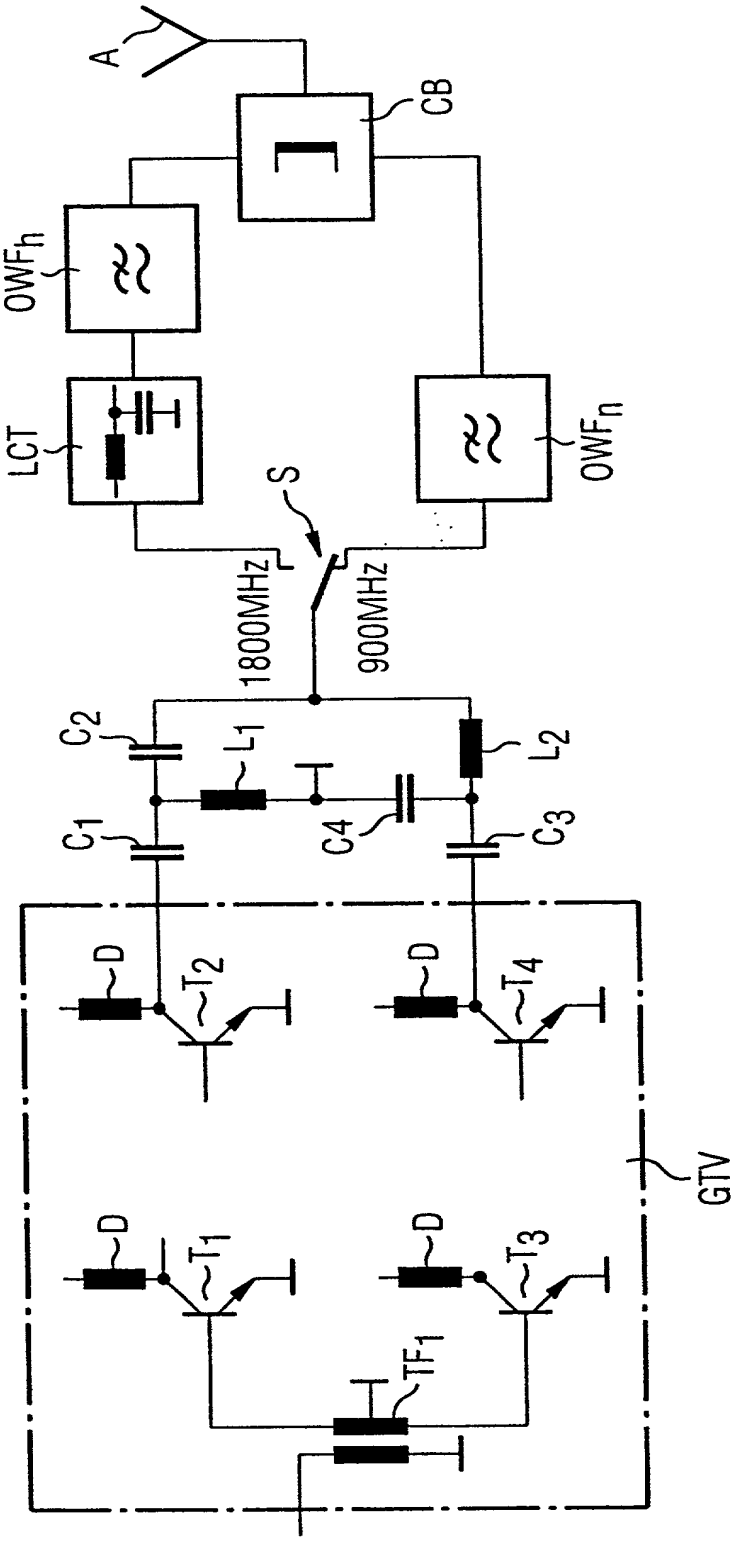
A
CB
OWFh
LCT
S
OWFn
1800MHz
900MHz
C2
L1
L2
C1
C4
C3
D
T2
D
T4
GTV
D
T1
D
T3
TF1

FIG 1

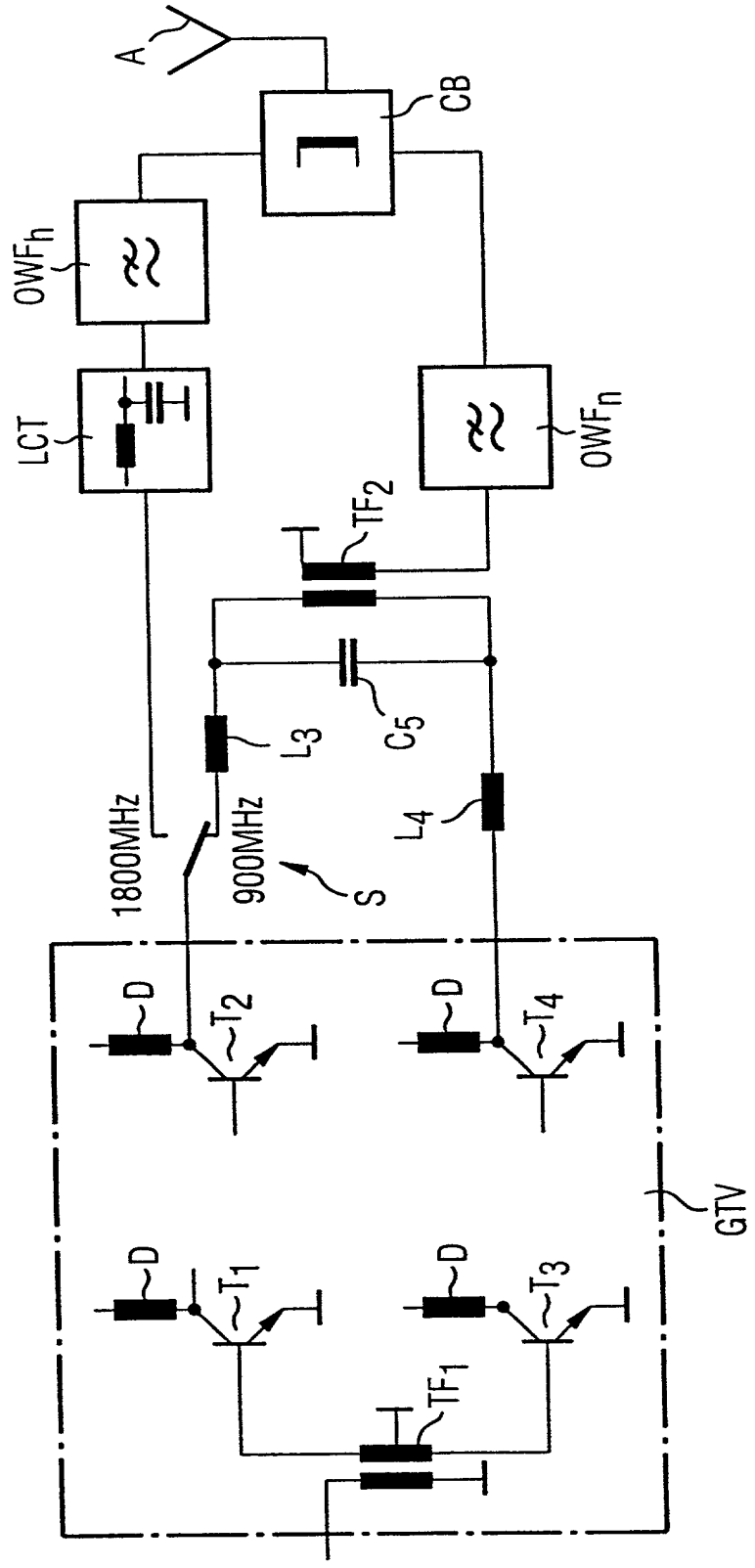
A
CB
OWFh
OWFn
LCT
TF2
L3
C5
L4
1800MHz
900MHz
S
D
T2
T4
T1
T3
TF1
GTV

FIG 2

2/PRTS

Description

Transmission output stage for a mobile telephone

The invention relates to a transmission output stage for a mobile telephone and, in particular, relates to a transmission stage for such a mobile telephone which is designed for two frequency bands.

At present, multiband mobile telephones are being developed and the first types are on the market which can operate at two operating frequencies, that is to say at 900 MHz and 1800 MHz in Europe in accordance with the relevant system definitions, whereas the 900 MHz and 1900 MHz frequencies are being used in the USA.

First developments operate with narrow-band parallel amplifier chains in the transmit and receive section. Such dual-band output stages thus have for each frequency band an amplifier optimized for this band which is associated with a considerable expenditure on components and, therefore, with costs and space requirement. A dual-band output stage of this type having separate amplifier branches for each band is, for example, the TST0911 chip by the manufacturer TEMIC. When the chip is used in a mobile telephone, the two outputs of the chip are conducted to an antenna via a diplexer. Here, too, the disadvantages are the costs and the circuit board area needed and the necessary expenditure for filtering the harmonics.

To lower costs, the aim is to be able to process the two frequency bands with one amplifier chain. Thus, in the article by V. Güngerich, M. Pöbl: "Bessere Handys durch Gallium-Arsenid MMICs" [Better mobile telephones by using Gallium-Arsenid MMICs], Elektronik 8/1998, p. 90-96, the structure of a CGY0819 amplifier chip by Siemens for multifrequency mobile telephones is described which exhibits separate RF inputs, the signals being conducted via a narrow-band amplifier in the respective band and the necessary output power being generated in a common output

stage. In this arrangement, the preliminary stages can be switched on and off separately from one another depending on the operating state.

Since, therefore, the common output amplifier operates both for 900 MHz and for 1800 MHz, it is mandatorily of wide-band design. In 900 MHz operation, a strong first harmonic is, therefore, mandatorily produced at 1800 MHz. This harmonic can only be suppressed with additional filters which result in considerable insertion loss of the useful signal at the fundamental frequency and need additional components. Furthermore, the matching elements must be elaborately switched with the aid of switches, for example PIN diode switches or diplex filters at the output of the transmit transistor.

The invention is, therefore, based on the object of creating a transmission output stage for a multifrequency mobile radio device which simplifies the critical switching of the output match of a dual-band transmission output stage for both frequency bands with simultaneous good suppression of the first harmonic of the lower-frequency signal.

The object is achieved by the features of claim 1. Preferred embodiments of the invention are the subject matter of the subclaims.

In a transmission output stage according to the invention for a multifrequency mobile telephone, the transmit signal is generated by a push-pull output stage during operation at the low frequency whereas the transmit signal is generated in single-ended operation of the push-pull output stage during operation at the higher frequency.

The single-ended operation can be generated by coupling the signal out of only one output transistor whereas the other output transistor is cut off. Furthermore, the single-ended operation can be achieved by switching off the supply voltage or cutting off the

transistors for one branch of the push-pull output stage. It is also possible to arrange in one branch of the push-pull amplifier a switch which causes this branch to be short-circuited when the transmission output stage is operated in single-ended mode. For this purpose, a PIN diode switch or an FET switch is preferably used.

The transmission output stage preferably exhibits an output matching circuit. The transmission output stage can also exhibit a harmonic filter for the low frequency and a harmonic filter for the high frequency, the transmission output stage also exhibiting a switch which conducts the signal to the appropriate harmonic filter in accordance with the frequency band currently used.

Furthermore, an LC transformer which is used for matching the load impedance of the high-frequency branch to the antenna impedance is arranged in the output branch of the high frequency.

The output to the antenna or to the antenna combiner for the high-frequency band is preferably blocked during operation in the low-frequency band in the transmission output stage. A switch which is implemented by a PIN diode switch or an FET switch can be used for blocking the output to the antenna or to the antenna combiner.

Either 900 MHz and 1800 MHz or 900 MHz and 1900 MHz are preferably used as frequencies. In this case, the first set of frequencies, namely 900 MHz and 1800 MHz, is used in Europe whereas a device is ready to operate in Europe and the USA with the second set of frequencies, i.e. 900 MHz and 1900 MHz.

The invention has the following advantages: due to the push-pull operation for generating the output power at the lower frequency by means of a push-pull output stage, the first harmonic is already additionally suppressed by 20...30 dB

which considerably lowers the expenditure for suppressing harmonics. Since the power is distributed to two transistors or branches of the push-pull output stage, the same amount of semiconductor material is required as in the single-ended operation with one transistor previously used. During operation at the higher frequency, single-ended operation is carried out as explained above. Since, in the case of GSM, the doubled frequency (1800 MHz) requires only half the power as the low frequency (900 MHz), the transistor (the transistors) is optimally driven in both bands. Furthermore, with the design of the matching circuit according to the invention, the matching elements of the push-pull circuit can also be used for the single-ended coupling-out at the doubled frequency which further reduces the circuit expenditure.

In the text which follows, preferred embodiments of the invention will be explained with reference to the drawings, in which:

Figure 1 shows a circuit diagram of a first embodiment of the invention, and

Figure 2 shows a circuit diagram of a second embodiment of the invention.

The preferred embodiment of figure 1 diagrammatically shows a push-pull amplifier GTV which exhibits an upper branch consisting of transistors T_1 and T_2 and a lower branch consisting of transistors T_3 and T_4 to which the input signal is applied via a transformer TF. For each transistor T_1, T_2, T_3 and T_4, a radio-frequency choke D is diagrammatically drawn in each case. The actual internal wiring or implementation of the push-pull amplifier is of no significance here and is not, therefore, shown. The only significant factor is that the push-pull amplifier GTV outputs two output voltages which are phase-shifted by 180°. These output signals are conducted, via an output matching circuit consisting

of the capacitances C_1 and C_2 and an inductance L_1 in the upper branch and the capacitances C_3 and C_4 and the inductance L_2 in the lower branch, to a switch S for the case of operation at 900 MHz. The output matching circuit provides an impedance match and a resultant phase difference of 0^0 of the two signals due to the LC section L_1, C_2 of the upper branch and the LC section L_4, L_2 of the lower branch. The first harmonic which is at 1800 MHz with an operation at 900 MHz is already suppressed by 20 to 30 dB by using the push-pull amplifier. To completely meet the requirements of the GSM standard at 900 MHz operation, the signal is conducted via the switch S to a harmonic filter OWF_n which performs the appropriate filtering. The transmit signal passes to an antenna A via a combiner CB.

When the transmission output switch is operated at 1800 MHz, the push-pull amplifier GTV is operated in single-ended mode by deactivating, for example, the lower branch. This can be done by cutting off the lower branch T_3 and T_4, for example by switching off the direct-voltage supply of the lower branch, or connecting (short-circuiting) the base, for example of the transistor T_4 (or T_3), to ground by means of a PIN diodes switch. The signal of the push-pull amplifier GTV in single-ended mode is passed via the high-pass filter formed by the elements C_1, C_2 and L_1 through to the switch S which, in the 1800 MHz position, applies the signal to an LC transformer which produces the necessary impedance match to the antenna A. The signal is then filtered in a harmonic filter OWF_n for the high frequency in order to filter the harmonics out of the signal in accordance with the GSM standard. The transmit signal passes through the antenna A via the combiner CB.

Figure 2 shows a second embodiment of the transmit stage which differs from the embodiment of figure 1 in the output matching circuit. The output signals of the push-pull

amplifier GTV here pass to an LC transformer consisting of the inductances L_3 and L_4 and the capacitance C_5, which is followed by a push-pull transformer TF_2, in the case of operation at the lower frequency, the switch S being set to the lower position for the 900 MHz operation. This output matching circuit provides for the necessary impedance match to the antenna and for a phase difference of 0° of the signals so that these are combined in the correct phase before the harmonic filter OWF_n for the low frequency.

In the case where the transmission output stage is operated at the high frequency, 1800 MHz in this case, the push-pull amplifier is operated in single-ended mode as in the first embodiment of figure 1 and the output signal passes via the switch, which is in the 1800 MHz position, directly to the upper branch consisting of an LC transformer LCT and the harmonic filter OWF_h for the high frequency.

Patent Claims

1. A transmission output stage for a multifrequency mobile telephone, characterized in that the transmit signal is generated by a push-pull output stage (GTV) during operation at the low frequency whereas the transmit signal is generated in single-ended operation of the push-pull output stage (GTV) during operation at the higher frequency.

2. The transmission stage as claimed in claim 1, characterized in that the single-ended operation is generated by coupling the signal out of only one output transistor (T_2) whereas the other output transistor (T_4) is cut off.

3. The transmission output stage as claimed in one of the preceding claims, characterized in that single-ended operation is achieved by switching off the supply voltage or switching off the transistors for one branch (T_3, T_4) of the push-pull output stage (GTV).

4. The transmission output stage as claimed in either of claims 1 and 2, characterized in that, in one branch (T_3, T_4) of the push-pull amplifier (GTV), a switch is arranged which causes this branch (T_3, T_4) to be short-circuited when the transmission output stage is operated in single-ended mode.

5. The transmission output stage as claimed in claim 4, characterized in that the switch is a PIN diode switch or an FET switch.

6. The transmission output stage as claimed in one of the preceding claims, characterized in that the transmission output stage exhibits an output matching circuit (C_1, C_2, L_1, C_3, C_4, L_2; L_3, L_4, C_5).

7. The transmission output stage as claimed in claim 6, characterized in that the transmission output stage exhibits a harmonic filter

(OWF_n) for the low frequency and a harmonic filter (OWF_h) for the high frequency, the transmission output stage exhibiting a switch (S) which conducts the signal or the signals, respectively, to the appropriate harmonic filter (OWF_n, OWF_h) in accordance with the frequency used.

8. The transmission output stage as claimed in either of claims 6 and 7, characterized in that an LC transformer (LCT) is arranged in the branch of the harmonic filter (OWF_h) of the high frequency.

9. The transmission output stage as claimed in either of claims 6 and 7, characterized in that an LC transformer is arranged in the branch of the harmonic filter (OWF_n) of the low frequency.

10. The transmission output stage as claimed in one of the preceding claims, characterized in that the output to the antenna (A) or to an antenna combiner (CB) for the high-frequency band is blocked during operation in the low-frequency band.

11. The transmission output stage as claimed in claim 10, characterized in that a switch which is implemented by a PIN diode switch or an FET switch is arranged in the transmission stage for blocking the output to the antenna (A) or to the antenna combiner (CB).

12. The transmission output stage as claimed in one of the preceding claims, characterized in that either 900 MHz and 1800 MHz or 900 MHz and 1900 MHz are used as frequencies.

GR 98 P 2879

Abstract

Transmission output stage for a mobile telephone

In a transmission output stage for a multifrequency mobile telephone, the transmit signal of operation at the low frequency is generated by a push-pull output stage which is operated in single-ended mode for generating the transmit signal at the higher frequency.

Fig. 1

Combined Declaration For Patent Application and Power of Attorney (Continued) (Includes Reference to PCT International Applications) PCT/DE99/00037

ATTORNEY'S DOCKET NO. 112740-203

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject mater of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS		STATUS (Check one)		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.

PCT APPLICATION NO	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (if any)			

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	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY
203	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
X Thomas Moliere		
DATE X July 11th, 2001	DATE	DATE

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY
(Includes Reference to PCT International Applications) PCT/DE99/00037

ATTORNEY'S DOCKET NUMBER 112740-203

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name, I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

TRANSMISSION OUTPUT STAGE FOR A MOBILE TELEPHONE

the specification of which (check only one item below):

☐ is attached hereto.

☒ was filed as United States application
Serial No. 09/806,974

on April 6, 2001

and was amended

on _____ (if applicable).

☐ was filed as PCT international application

Number _____

on _____

and was amended under PCT Article 19

on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Germany	198 46 069.4	06 October 1998	☒ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO